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Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Ship Fumigation

Contents

Methods and Procedures

The procedures covered in this section provide commercial fumigators with the methods, responsibilities, and precautions for ship fumigation.

CAUTION

These procedures are used primarily for fumigation of ships that are infested with khapra beetle.

Generally, fumigation of commodities within the structure of a ship, such as cargo holds, cannot meet APHIS standards for fumigation, and these fumigations are not recommended by APHIS. However, on a case by case basis, commodities may be fumigated within the structure of a ship if Methods Development first approves the fumigation. For approval, call Oxford Plant Protection Laboratory (tel: 919-693-5151.)

In general, ship fumigations present problems not encountered in other types of fumigations. The large amount of gas required and the varying space configurations from ship to ship make it essential that experienced pest control operators and PPQ officers with extensive fumigation experience perform ship fumigations.

Materials Needed

PPQ Officer Provides

- PPQ Form 429
- Calculator (optional)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®)
- Halide leak detector
- SCBA or supplied air respirator
- Tape measure
- Thermal conductivity unit[1]
- Thermometer

Fumigator Provides

- Adhesive sealer, tape, and putty or other pliable material for sealing off holes around pipes
- Auxiliary pump for purging long gas sample tubes
- Carbon dioxide filter (Ascarite®)
- Colorimetric tubes (Draeger/Kitagawa)
- Electrical wiring (ground, permanent type), three prong extension cords
- Exhaust blower and ducts

1 T/C unit must be calibrated annually by the Oxford Plant Protection Laboratory. If requested, the Oxford Plant Protection Laboratory will calibrate a commercial fumigator's T/C unit.

- Fans (circulation, exhaust, and introduction)
- Framework and supports
- Gas sampling tubes (leads)
- Gas supply line
- Heat supply
- Insecticides and spray equipment
- Methyl bromide
- Padding
- Portable generator as backup unit to operate T/C unit, auxiliary pump, and lights
- Sand or water snakes
- Scales or dispensers
- SCBA or supplied air respirator
- Tape
- Tarpaulin and supports
- Thermal conductivity unit
- Volatilizer
- Warning signs

PPQ officer and fumigator should be prepared to use auxiliary power if shore power is not available as most ships' power is 220 volts.

Taking Safety Measures When Fumigating Ships

The most important consideration when fumigating ships is the protection of human life. The commercial fumigator has the following safety responsibilities when fumigating ships:

- Observe all safety precautions while fumigating
- Prevent access of unauthorized personnel, including the ship's crew, to the fumigated area
- Conduct fumigation properly to result in an effective treatment
- Evacuate gas from ship and aerate when fumigation is completed
- Test, with a gas detector, all areas aboard ship to ensure freedom from MB before allowing crew members access to the ship

The commercial fumigator must abide by the following guidelines when fumigating ships:

- Have a representative present throughout the entire fumigation. The representative must be familiar with directions for using the fumigant, warnings, antidotes, etc., shown on the label, on the gas cylinder, and contained in the manufacturer's application manual.
- Have adequate first-aid equipment, SCBA, and other safety equipment available
- Have all areas of the ship tested with a gas detector prior to crew re-entry. Pay particular attention to all fumigated areas, crew quarters, and the engine rooms
- Provide for immediate contact with the responsible ship's officer to provide information and access to areas of the ship which may be needed to assure a safe fumigation

Preparing to Fumigate

Step 1—Meeting With Ship's Captain and Agent

When planning a ship fumigation, meet with the ship's captain, agent, and the fumigation company representative to discuss the conditions of the fumigation. If cargo is present in an area about to be fumigated, determine if any materials might be adversely affected by the fumigant (see Methyl Bromide—Properties for a list of commodities adversely affected by MB). Notify the ship's agent of possible effects and if conditions permit, allow removal of the material from the hold for an alternate treatment.

Discuss plans for removing all crew from the ship. It is the responsibility of the commercial fumigator to comply with all label requirements, and with State, local, and U.S. Coast Guard regulations (see **Coast Guard Regulations** in **Appendix B**) concerning shipboard fumigation.

Step 2—Selecting a Treatment Schedule

Refer to treatment schedule T402 (SHIPS) for the correct treatment. Select a treatment schedule based on the plant pest and commodity to be fumigated. Consider all the commodities present in the area to be fumigated when determining the best treatment available. In the case of khapra beetle fumigation, determine if finely milled products (example—flour) will be fumigated. If finely milled products are to be fumigated, give the captain the option to use the 12 hour schedule. Have the finely milled products destroyed either by incineration or by sterilization after the fumigation has been completed. If the captain elects not to remove and destroy the finely milled products, then use the 24 hour treatment schedule.

Treating Deck Areas

Areas which may be pest contaminated or suspected of being contaminated, such as the deck, hatch covers, drain channels, crevices around hatches, hallways, and similar areas that cannot be fumigated, should be treated with a 3 percent malathion emulsion spray (0.5 pint, 57 percent premium grade to a gallon of water). Spray at the rate of 2 gallons/1,000 sq. ft., or to the point of runoff.

Malathion emulsion sprays may break down asphalt surfaces. For asphalt surfaces, prepare a spray from a 25 percent wettable powder (1 pound to a gallon of water), rather than the emulsion.

Step 3—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine if the schedule is a FIFRA Section 18 Exemption by the presence of broad, bold, vertical lines on the borders of the treatment schedule table listed in the reference. Some treatment schedules are FIFRA Section 18 Exemptions only at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a FIFRA Section 18 Exemption.

If food is fumigated, alert the captain that there may be higher than permitted residues.

Step 4—Preparing Areas to Be Fumigated

Storerooms

Open all bins, drawers, and cupboards. Stack all bagged commodities so gas can penetrate all sides of the commodity. Stacking bagged commodities on pallets will facilitate gas distribution and penetration.

Cargo Holds

Prepare to fumigate the entire hold regardless of the location of the infestation within the hold. If you want to fumigate a single deck (lower hold, lower 'tween deck, upper 'tween deck, etc.), you must get approval from your Regional Director. The decision to approve single deck fumigations should only be made after all sections of the hold have been inspected and there is no possibility of gas escaping to other parts of the hold.

In most cases, it is unnecessary to open or rearrange cargo containers within the hold. Occasionally, some rearrangement may be required to ensure uniform gas distribution. Have the hatch coverings between decks opened in such a manner as to permit adequate distribution and circulation of the gas.

Step 5—Arranging and Operating Fans

Storerooms

Storerooms normally require a minimum of two, 1,800 cfm fans. Place one fan at a low level and the other at a high level. Fans with capacity above 1,800 cfm create strong air currents which could result in gas leakage around the seals. If you're fumigating an area which includes

the galley and adjoining storerooms, be sure to place the fans to evenly distribute gas. Make certain that fans can be turned on and off from an area outside the fumigation site.

Cargo Holds

Use the volume of the hold (ft^3) in determining how many fans you will need. The total cfm's of all the fans should approximate the volume of the hold. Use fans capable of 2,500 cfm or greater during gas introduction and for 30 minutes following the introduction. Placement of fans within holds depends on the presence or absence of cargo. Normally, place two fans in the lower hold at opposite ends facing across the hold. The number of fans can be reduced by using fans greater than 2,500 cfm. Fans should be labeled as to location and have the capability of being turned on and off individually in case of low readings in certain locations or pockets of gas.

Test all fans to ensure that they are in good operating condition. Operate fans during the gas introduction and for 30 minutes after introduction is completed.

Step 6—Placing Gas Sampling Tubes

Place gas sampling tubes in areas and commodities which will give representative samples within the fumigated area. Have all leads brought to one central point at least 30 feet up- wind from the area being fumigated. Label all gas sampling tubes so they can be easily identified when you take concentration readings. Label each tube by identifying the level of the hold and whether the gas sampling tube is in a commodity or space.

Storerooms

Place a minimum of two gas sampling tubes in open space and at least one gas sampling tube within the commodity considered to be the most difficult for the fumigant to penetrate.

Cargo Holds

Within cargo holds, the exact location will depend primarily on the location of cargo within the hold. Place a minimum of two leads for each level of empty hold space. The average size hold of three levels is approximately 125,000 ft^3. Use one additional lead for every 50,000 ft^3 over 125,000 ft^3.

When cargo is present in the hold, place two additional gas sampling tubes in the commodity at each hold level. For mixed cargo, place additional gas sampling tubes in the cargo considered to be the most difficult for the fumigant to penetrate.

Step 7—Placing the Gas Introduction Lines

Storerooms, Galley, Quarters

Numerous gas introduction lines may be necessary in order to obtain even gas distribution throughout the fumigation area. Place the gas introduction line directly through an opening from the outside (example—a door or window) directly above a fan. Attach the introduction line securely to the top of the fan to prevent movement of

the hose. An unsecured introduction line could move the line out of the airflow. Place a piece of nonpermeable sheeting (example—plastic or rubberized canvas) over the commodity in front of and below each gas supply line. The nonpermeable sheet will prevent any liquid MB from coming in contact with commodities and will prevent damage.

Cargo Holds

Numerous gas introduction lines may be necessary in order to obtain even gas distribution throughout the fumigation area. Place the gas introduction line directly into the air stream in front of one of the fans on the upper 'tween deck. Attach the introduction line securely to the top of the fan because gas passing through the line will cause the line to vibrate. An unsecured introduction line could be moved out of the airflow. Additional introduction lines can be used to hasten introduction and distribution of the gas. Place a piece of nonpermeable sheeting (example—plastic or rubberized canvas) over the commodity in front of and below each gas introduction line. The sheet will prevent any liquid MB from coming in contact with the cargo and prevent damage.

Step 8—Measuring the Temperature

Take temperature readings of the air (space) and of the commodity. Use a calibrated thermometer. Record the temperatures in Block 22 on the PPQ Form 429. If the temperature is below the minimum listed for the treatment schedule, then you will need to heat the hold or other space to be fumigated.

TABLE 2-6-1: Determine Pre-fumigation Procedures

If the temperature is:	Then:
At or above the minimum temperature listed for the treatment schedule	GO to Step 10 (Sealing Stores)
Below the minimum temperature listed for the treatment schedule	GO to Step 9 (Heating the Cargo Hold)

Step 9—Heating the Cargo Hold

If heating a hold is necessary, negotiate the method with the fumigator and get the concurrence of the Oxford Plant Protection Laboratory.

Step 10—Sealing Stores

One of the most important steps in preparing for a ship fumigation is sealing all openings and areas which have the potential to leak gas. Consider the entire area to be fumigated as a natural atmospheric chamber and make the area as gastight as possible. The most important task is to locate all openings (example—drain pipes, bilge drain holes, or air ducts) and seal them.

Do ***not*** seal out or make gastight recessed areas, ducts, or similar apertures which may harbor an infestation. In some cases it is better to seal sources of leaks on the outside of the area to be fumigated. Use

caulking compound or tape for sealing small spaces. For sealing larger areas, use polyethylene or similar material secured with tape or adhesive spray. Seal doors and other openings with either polyethylene or spray with vinylite plastic. When practical, seal air ventilation ducts on the outside of the space being fumigated so sealing tape can be removed when you get ready to evacuate the gas and begin aeration. Large openings such as hatch cover openings should be covered with polyethylene and securely taped. When necessary, lace rope across the tarpaulin to prevent billowing in high winds. Look for and seal off the following ship areas when preparing a ship for fumigation:

- Wall plates
- Air vents
- Drains
- Pipes and other utility conduits through decks and bulkheads
- Dumb-waiter openings
- Heating, air conditioning, and ventilation systems common with or to cargo holds, engine room, crew quarters, storerooms, or other spaces that use intake from the vent systems common with cargo holds
- Engine room—recirculation air systems controlled from and common with the engine room areas—especially on newer ships; check for drilled holes or other openings in fore and aft bulkheads of engine room spaces, all engine room vent systems, and housing or casing leading into spaces to be fumigated
- All passageways, engine room, and other crew areas for electric pipeline or other duct work common with cargo holds
- Speaking tubes and fire and smoke detector systems from fumigated areas
- Emergency escape hatches from shaft alley and escape hatches from all holds
- CO_2 piping to all cargo holds; degassing systems (older ships) which usually run from hold to hold
- Vents in shaft alley and gear lockers to holds; breaks in bulkhead
- Bilge and drainwell vents and drains to all cargo holds sometimes common with more than one hold or engine room bilges
- Steam-smothering systems for connection between holds
- Inner bottom and deep tank covers to ensure that they are closed prior to fumigating

- Galley intake and exhaust systems (may be common with the dry stores)

Step 11—Measuring Volume

Obtain the volume of the cargo holds from the chief mate, captain, or the ship's plan, which is usually posted outside the captain's office. If actual hold measurements are available, then figure the volume by multiplying the length, width, and height of the hold. If actual measurements are not available, then look on the ship's plan for the grain cube. Use the grain cube as the volume in lieu of actual hold dimensions. Consider all hold areas such as deep tanks, security lockers, and refrigerated spaces when calculating the volume of the area to be fumigated.

For dry stores, galleys, and crew quarters, measure the actual dimensions to calculate volume.

Step 12—Calculating Dosage

The formula for calculating dosage is:

$$\text{dosage(lbs.)} = \text{volume(ft}^3\text{)} \times \text{dosage rate(lbs./1,000 ft}^3\text{)}$$

$$= \frac{\text{volume(ft}^3\text{)} \times \text{dosage rate(lbs.)}}{\text{1,000 ft}^3}$$

EXAMPLE: Number 3 Hold is infested with khapra beetle. The volume is 80,000 ft^3, and the temperature is 65 °F. The treatment schedule lists the dosage rate as 6 lbs. MB/1,000 ft^3. To calculate the dosage multiply the volume (80,000 ft^3) by the dosage rate (6 lbs./1,000 ft^3). This equals 480 lbs. of MB needed for the dosage.

Step 13—Making a Final Check

Just before introducing the gas, you and the fumigator must do the following:

- Prior to fumigation, use a halide detector to check all storeroom and reefer areas which have any refrigerating systems prior to fumigation. A halide detector will indicate any freon leaks. Freon, a halide gas like MB, will result in higher concentration readings. Also, after aeration is completed, freon leaks may falsely indicate that MB is still present within the fumigated area.
- Take T/C unit readings to determine if any contaminant gases are present
- Turn on all fans and T/C unit to make sure they work
- Start volatilizer and heat water to 200 °F or above
- Place fumigant cylinder with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight,

subtract the dosage to be introduced into the enclosure. When the entire dosage has been introduced, the scale will be balanced.

- Check to make sure the ship's gangway and areas to be fumigated are properly placarded and the area is secured. A guard should be present at the entrance to the gangway to restrict access to the ship. If the crew has been removed, walk through the quarters and other areas to make sure no one is aboard.
- Check all sealed areas to make sure they are securely taped and free from holes
- Check the gas introduction line connections to make sure they are tight
- Check to make sure all safety equipment is available and in working order

Conducting the Fumigation

Step 1—Introducing the Gas

PPQ Officers must wear the SCBA anytime they are within 30 feet of area being fumigated. You and the fumigator both must use SCBA while introducing the gas, checking for leaks, and when taking aeration readings.

Turn on all fans while introducing the gas. When using large cylinders of MB, have the fumigator slightly open the valve then close the valve. Using a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, have the fumigator tighten the connections and repeat the test. If no leaks are found, have the fumigator open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The gas introduction line should always feel hot and the volatilizer must read at least 150 °F.

Do not touch the introduction line with your bare hands—you may get burned! Have the fumigator close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins when all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes after all the gas has been introduced. You will take the initial concentration reading 30 minutes after all the gas has been introduced.

When using cylinders, getting the final amounts of gas out of the cylinder may take a long time. Consider taking T/C unit readings 30 minutes after the gas is first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at an adequately high concentration, then you can turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge at its slow rate with intermittent running of the fans for dispersal.

Step 2—Taking Concentration Readings

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the area being fumigated (galley, storeroom, or cargo holds). Check Drierite® tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times after the introduction of the fumigant:

- 30 minutes
- 2 hours
- 4 hours
- 6 hours
- 12 hours
- 24 hours
- 48 hours
- 72 hours (for *Cochlicella*, *Helicella*, and *Monacha* spp.)

Consult the treatment schedule being used for the actual concentration readings. You may start the final concentration reading 30 minutes prior to the end of the exposure period.

Take additional readings when there is indication that the gas is not properly distributed or the minimum gas concentration is not being maintained. Record readings on PPQ Form 429.

Step 3—Testing for Leaks

Wearing the SCBA, use a halide detector to test for leaks after all the gas has been introduced. Test around the perimeter of the area being fumigated, especially where doors, windows, pipes, electric cords, gas sampling tubes, and gas introduction lines are present. If you detect leaks, be sure they are sealed with additional tape, adhesive, or by placing more polyethylene and adhesive over the leaking areas.

Step 4—Adding Gas and Extending Exposure

You may add gas at the following rate when concentration readings fall below the minimum:

1.6 × number of oz. below minimum × volume/1,000 = oz. of gas to add

EXAMPLE: You are fumigating a ship's storeroom for khapra beetle and the minimum concentration for the 2 hour reading is listed at 50 oz. but your readings average 45 oz. The volume of the storeroom is 1,500 ft^3. Using the above formula, you would figure the following:

1.6 × 5 (oz. below min.) × 1,500/1,000
8 × 1.50 = 12 oz. gas to be added

Extending Exposure Period

Use **Table 2-6-2** to determine how long to extend the exposure period:

TABLE 2-6-2: Determine Time for Extended Exposure

If the exposure time is:	And the reading is below minimum by:	Then extend exposure:
Less than 12 hours	10 oz. or less	10 percent of the time lapse since the last reading
	11 oz. or more	30 minutes
12 hours or more	10 oz. or less	10 percent of the time lapse since the last reading
	11 oz. or more	2 hours or 10 percent of time lapse since last reading, whichever is greater

Step 5—Exhausting the Gas

Exhaust the gas at the completion of the exposure period. If the treatment schedule is a FIFRA Section 18 Exemption, then you must monitor the aeration of the fumigated area. Use **Table 2-6-3** to determine if you need to monitor the aeration of the fumigated area:

TABLE 2-6-3: Determine the Responsibility for Monitoring the Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW "Aerating the Hold or Storeroom" steps which follow.
A labelled treatment	RELEASE the fumigation to the fumigator and RELEASE the ship.

Removal of the fumigant from cargo holds is facilitated by using an outside blower to force fresh air through portable canvas, plastic, or similar ducts. Another method is to use compressed air hoses to force fresh air into the bottom of the hold. Use fans or blowers within the fumigated space to help aerate the hold. Use suction type fans with portable ducts to evacuate gas from storerooms to outside, downwind areas away from crew areas, preferably on the offshore side of the ship. Do not point the ducts upward, since dissipation onto the deck may occur. Use the ship's aeration/ventilation equipment if possible. Make sure that use of ship's equipment will not distribute the exhausted gas to other areas within the ship.

Aerating the Hold or Storeroom

Step 1—Securing the Area

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. During the first 10 minutes of aeration, there should be no people within 200 feet of the exhaust duct outlet. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

Have the fumigator use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as "AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE"; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do *not* allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Area

Wearing the SCBA, advise the fumigator to make an opening (if possible) at the end furthest from the exhaust duct to allow entry of fresh air. The fumigator may open doors, hatches, tarpaulins, and areas to facilitate aeration. Start the exhaust system (minimum 3,500 cfm exhaust fan connected to an exhaust duct) and aerate the hold or storeroom.

Step 3—Taking Concentration Readings to Determine When to Release the Ship

Stop the aeration fans. Take a concentration reading with a colorimetric tube in the exhaust duct within 2 feet of the storeroom or within the first 2 feet of the exhaust duct where it exits the hold. If the concentration is above 5 ppm, but less than 100 ppm, advise the fumigator to remove the tarpaulin while wearing a SCBA.

Release the ship when the following conditions are met:

For Storerooms When the concentration is 5 ppm or less after taking readings 4 feet from the floor and 1 foot inside the fumigation perimeter at several representative locations (a minimum of two are required).

For Holds When the concentration is 5 ppm or less after taking readings by:

1. Drawing a sample for a minimum of 1 minute through a sampling tube with the auxiliary pump. The sampling tube should be teflon or metal to obtain accurate readings. If a polyethylene sampling tube is used, it should be replaced at frequent intervals due to adsorption of gas by the polyethylene.
2. Taking a concentration reading with a colorimetric tube in the sampling tube.
3. Taking a minimum of two readings for each level of the hold.

Record the date, concentration reading, and time on PPQ Form 429.